Executive Summary of Detailed Feasibility Study

Wastewater Management Plan for Selected Clusters of Ambajogai

August 2014

Prepared by

Consortium for DEWATS Dissemination Society

In association with

pas performance assessment system

CEPT University

Acknowledgements

The detailed feasibility report for Ambajogai was prepared by the PAS team in collaboration with Consortium for DEWATS Dissemination (CDD) Society as a part of the PAS Project support to the Government of Maharashtra (GoM) on sanitation related activities. The focus of feasibility report was to identify at scale, low cost decentralized sanitation solutions in small and medium towns. This initiative was part of the City sanitation plan exercise that was taken up for Ambajogai by PAS Project, CEPT University in partnership with the Water Supply and Sanitation Department (WSSD, GoM) and Maharashtra Jeevan Pradhikaran (MJP).

We would like to thank the President and elected representatives of the Ambajogai Municipal Council (AMC) for their active participation and support during the entire process of CSP and feasibility report preparation. This report has not remained on paper; it is planned to be implemented, largely due to the efforts of the Chief Officer of the AMC, Mr Jamwar. Support from other officials of the AMC, particularly Mr Lahane, City Engineer, was valuable in the preparation of this report.

The field work and data collection for this feasibility report was carried out by CDD society. The PAS team at CEPT and CDD society worked further on analysis of information. The team worked closely with AMC officials in identifying various options and developing the final action plan.

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Introduction

About the Project

Performance Assessment system (PAS) Project, CEPT University has collaborated with the Consortium for DEWATS Dissemination (CDD) Society to prepare a plan for appropriate wastewater treatment facilities in 4 selected clusters of the town of Ambajogai in Maharashtra. For this town, CEPT has earlier prepared a City Sanitation Plan (CSP) adopting its 'Framework for Citywide Sanitation Assessment' as an approach. The project was conducted in partnership with the Water Supply and Sanitation Department (WSSD), Government of Maharashtra and Maharashtra Jeevan Pradhikaran (MJP).

This study embraces the emphasis laid by the National Urban Sanitation Policy on adopting alternative approaches for addressing sanitation needs. It is a unique endeavor in that it studies the feasibility of integrating conventional and non-conventional approaches for implementing a wastewater management system within a town.

The study paradigm is a departure from the traditional approach of meeting wastewater management needs through implementation of conventional drainage systems and establishing centralized treatment plants. Instead alternative low cost solutions for wastewater management are conceptualized by taking into account the Physiographic profile of the un-served clusters in the town.

About Ambajogai Municipal Council

Ambajogai is cultural capital of *Marathwada* region and is one of the six municipal towns in Beed district, Maharashtra, India. The town is known for the famous temple of *Yogeshwari devi* and *Makka Masjid*. There are several other heritage temples in Ambajogai and the first Marathi poet *Mukundraj* hailed from this town. Ambajogai is also known as upcoming educational hub in *Marathwada* region. The town also enjoyed capital status during *Yadava* Kingdom. With the fall of *Yadava* kingdom to the Muslim conquerors the name of the town was changed to *Mominabad* in 1903 A.D. which was later changed back in 1961 on the formation of Maharashtra state. The town with an area of 10.18 sq km accounts for entire urban area of the district. It is surrounded by two major cities - *Latur* on south, *Nanded* on north-east.

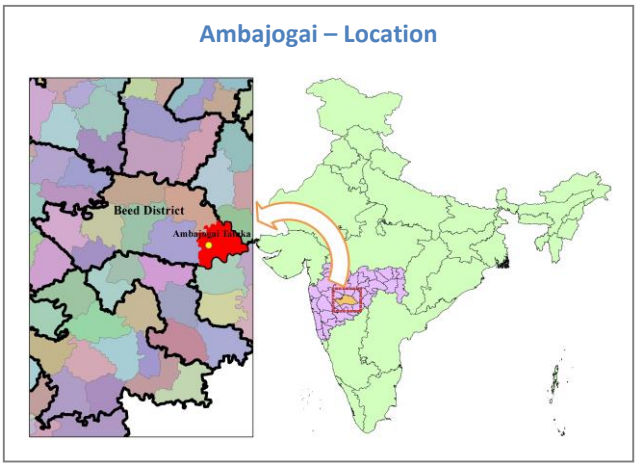
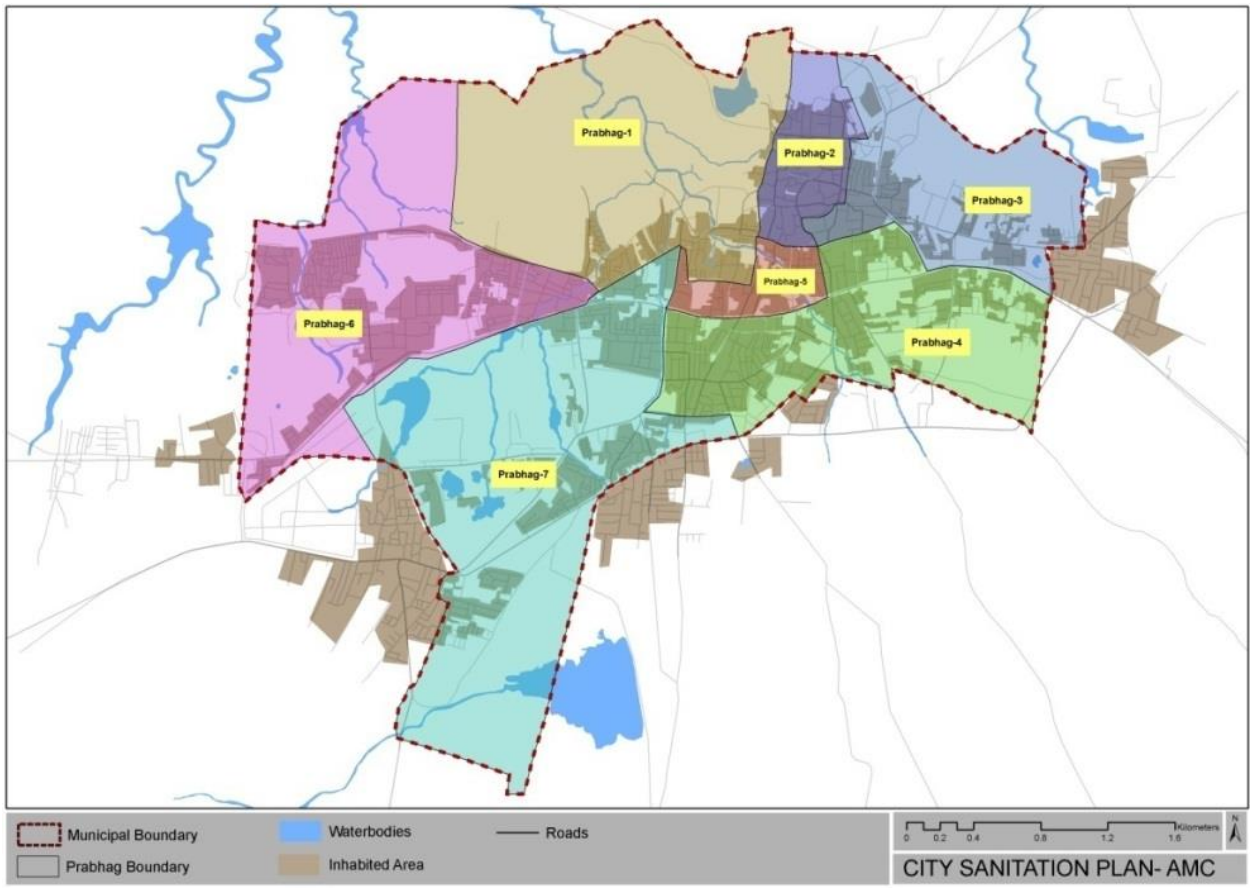


Table 1: Salient features of Ambajogai

District	Beed
Geographic Location	Latitude 18°44'N and Longitude 76°23'E
Connectivity	Connected by SH 156 and SH 162, 94 km from Latur & 110 km from Beed Nearest railway station- Parli Vaijnath- 23kms from town.
Civic status	Nagar Parishad B class
Area	10.18 sq km
Population (census 2011)	74,844
Number of Wards	7 prabhags (28 wards)

Source: Ambajogai Municipality, CSP Analysis

Ambajogai is located in the basin of River *Manhra,* a tributary of Godavari. It is divided into two halves by the river *Jayawanti* which takes its rise in the *Bhimkund Tirth* situated to the south of the town. Most of the streams and tributaries flow towards North West. *Jaywanti* River flows from south to north carrying almost 70-80% of storm and waste water. There are two lakes. One is northern side of the city called *Borda Talav*; while another is south side of the city. *Borda talav* is locally known as



Kashivisheshwar, and is used for rituals like emerging ashes of dead people. Now the lake is also utilized for recreational, domestic use like washing clothes. Two types of soils are found in the town. The northern part of the town, (Prabhag 1, 2, 5 & 6) has hard strata along with shallow to medium deep soil/ murum, whereas the southern part (Prabhag 3, 4 & 7) is covered by shallow to deep black cotton soil.

The older part of town consists of *Yogeshwari* temple precinct, market areas and other commercial establishments supplementary to temple. This area is densely populated and land holding size in the area is also low as compared to new developments in Prabhag 4 and 7. Newly developing areas are located in peripheral part of the town; with low population density as compared to core areas. Peripheral areas mainly consist of educational institutes and Government institutes. At present, the spread of urban areas is observed along major roads connecting *Beed*, *Latur*, *Plashkhed*, *Parlivelinath* and *Ghat Nadur*. These areas are linear growing areas with low density.

Sanitation sector assessment

Access to household and Community toilets

As per Census data, there are 14,517 households out of which 9,663 (66%) have individual toilets and the 4303 households practices open defecation which is about 30% of the total households.

Individual and Community level Sanitation facility in Ambajogai

The dependency on community toilet is very minimal at 4% only. There are 39 toilet blocks in the town, comprising of 249 seats, of which functional seats are even lesser than 50% due to which open defecation rates are high. Open defecation is generally observed on private owned open plots and open spaces such as along Nallas. 91% of households having individual toilets have pour flush toilets. Out of these around 88% of households have pour flush connection to septic tank which serves a purpose of primary treatment. Direct disposal of night soil to open drains is around 2% and is observed mostly in slum households along natural drains or Nallas. Prabhag 1, 3 and 6 depict comparative higher rates of open defecation. Prabhag 1 which comprises of *Yogeshwari temple complex* has 14 community blocks, out of which only 6 are functional. Prabhag 6 comprises of large number of slum pockets, low and medium income housing. The community toilets are maintained informally by women groups in local communities.

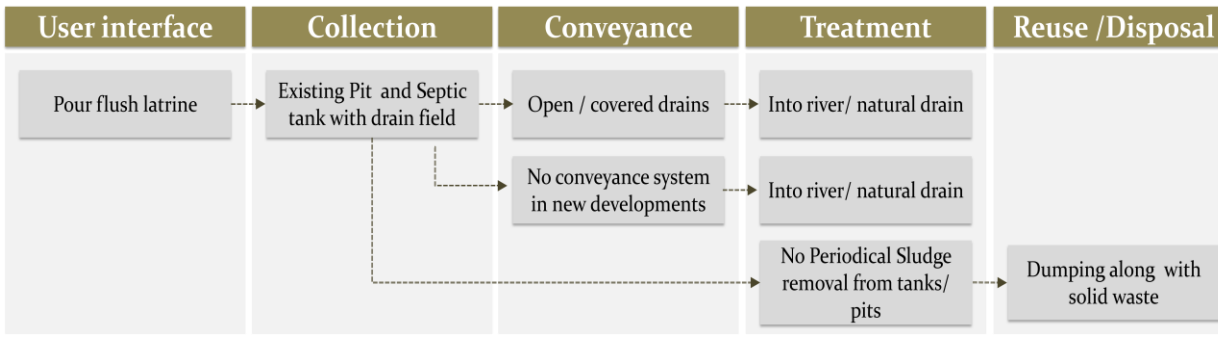
In densely populated areas, building toilets along roadside is the common practice, where built-up area of house is very small and compact packed settlements. In such areas, survey revealed in some instances superstructure is also construed above septic tank. The discharge of effluent from septic tank happens in open drains, which are clogged at several places. Most of the households do not have technically designed septic tank. Largely it was found to be single or double chambers along with baffled walls. The depth was found to be varying from 5’ to 6’ as per land availability, the construction in brick masonry, with plaster lining from both sides. Effluent is largely discharged into abutting open drain along road without any provisions of soak pits. Sample survey also revealed that around 95% households had not cleaned their septic tank in last 3 to 5 years.

Existing Domestic Wastewater and Septage management

Black Water Management

The town does not have underground sewerage system. Road side drains carry effluent from septic tanks as well as grey water. Effluent from septic tanks/ pits of individual as well as community toilets is directly discharged into open or closed drains along the streets along with grey water from kitchen and other wash areas.

Schematic flow diagram – Existing waste water system in Ambajogai



Large part of town has open (partially closed) drains along roads which carry waste water of the city while newly developing areas on the southern side of the city the colonies have irregular network of drains to carry waste water with their outlets in natural *nallas*/ drains. The absence of dedicated conveyance system for domestic waste water management and lack of any treatment mechanism is very much evident in Ambajogai. The wastewater is disposed into river *Jaywanti* without any treatment.

Discharge of black water / effluent from Septic tanks in to natural drains

In Ambajogai the services for cleaning of septic tanks is provided by local body. They use motorized 200 liter capacity vehicle with suction machine and charge Rs. 3000/- per unit for cleaning of a tank. As per the records available with the local authority, on an average about 50 septic tanks are cleaned annually, this may vary depends on the demand generated by the local people. The septage collected from the septic tanks is transported to the solid waste dumping site and is dumped in open without any treatment. Sample survey reveals that residents lack knowledge of functioning and maintaining the

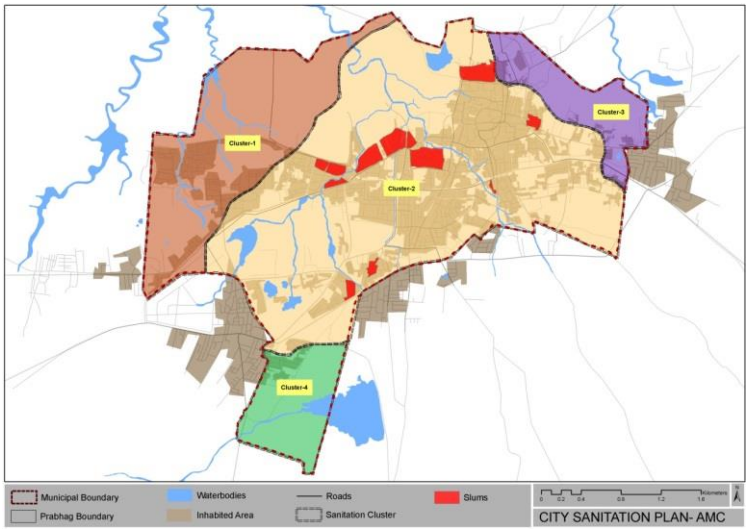
onsite treatment facility. Hence, the fecal part remains in the pit or tank itself for many years than desired period. In areas like *Raviwar Peth* and *Mangalwar Peth* superstructure is constructed above septic tank/ pits which restricts access for cleaning.

Grey Water Management

Considering 80% of waste water generation from the total supply quantity, the total wastewater generated is about 4.97 MLD. In Ambajogai, only 20% of the households are connected with closed drains which include major market area, along major roads and newly developed colonies. Rest of the city has either open drains (71%) or shows complete absence of drains (9%).

Discharge of grey water from kitchen and bathrooms into the drain channels

This scenario is observed mostly in the slum and new developed areas. The natural slope towards the river compels the flow of the town wastewater to contaminate river *Jaywanti*. Unhygienic conditions created by untreated sewage and sullage result in problems of odour, mosquitoes and flies. The town has two major ridge lines which divides it in to three parts in terms of catchments areas (Map 1). Cluster II covers almost 95% of the total city population discharges waste water in river. It covers seven Prabhag of the city except for a small area of Prabhag 3 and6. It adds highest quantity of waste water in the city, followed by cluster I at 0.9 MLD and cluster 3 at 0.1 MLD.

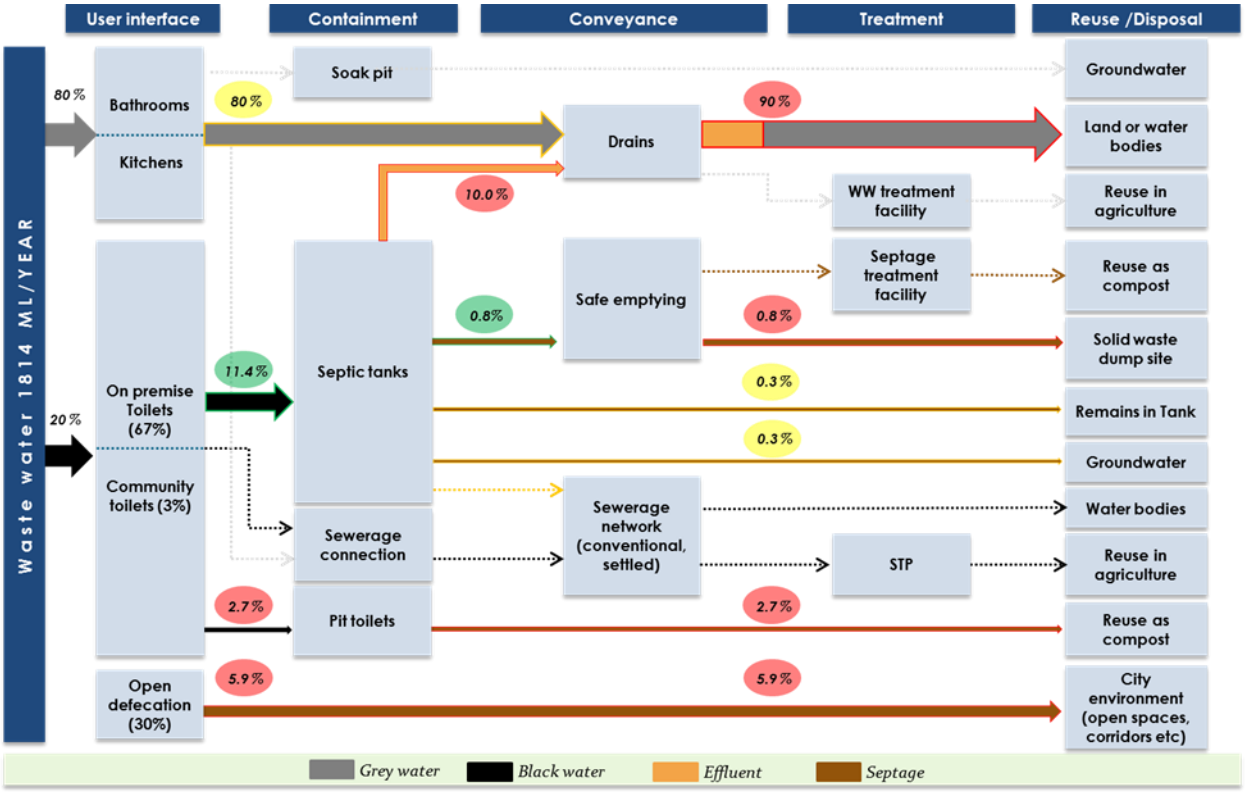


Map 1: Sanitation clusters (zones) based on wastewater generation and conveyance in Ambajogai

Illustrated in Figure 1 is the waste water flow diagram for Ambajogai. The flow diagram illustrates stages of the value chain as well as mentions the volumes of waste flowing through the chain. The untreated volumes and partially treated volumes are highlighted through red and yellow traffic lights respectively.

The fully treated volumes are highlighted through green traffic lights. Currently large part of grey water flows through drains and is discharged in to land/ water bodies without any treatment. There are no soak pits that are used for discharge of grey water. As illustrated in the waste water flow diagram, currently large part of grey water flows through drains and is discharged in to land/ water bodies without any treatment. The above diagram illustrates that 90% of volume of grey water gets discharged without any treatment. The soak pit route is not used at all. For the black water volumes, the septic tanks in case of household toilets are able to primarily treat 11.4% of volume but this entire volume does not get safely emptied. Less than 0.8% of black water volume is safely emptied, but even this does not go through treatment procedures. Thus a very negligible volume of black water gets partially handled across the value chain. Building by-laws state that it is necessary to develop an onsite treatment facility of septic tank followed by soak pit. However, very few buildings (especially newly developing

Figure 1: Existing waste water flows in Ambajogai

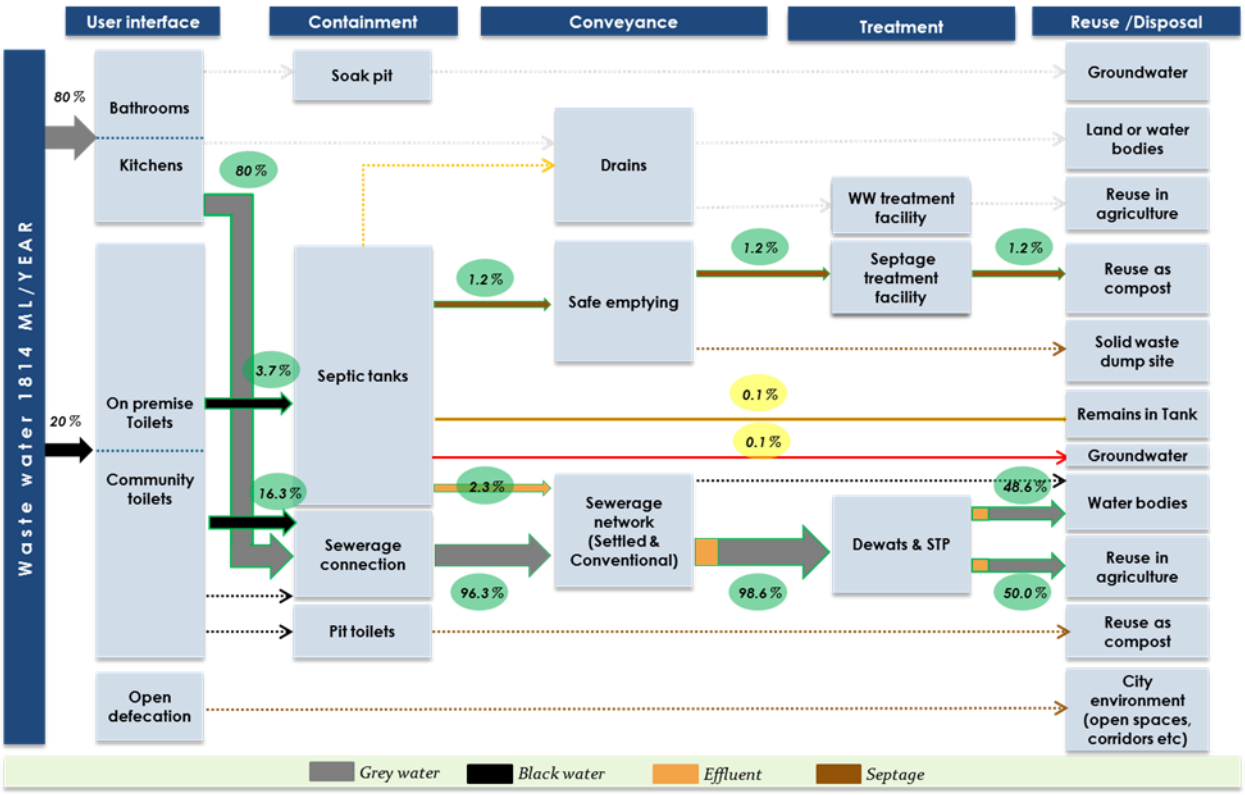


ones) follow the system thus lack in implementation and enforcement of byelaws. Surprisingly, the newly developing areas lack in conveyance network.

A sustainable waste water management plan for Ambajogai will essentially involve handling of entire waste water volumes and their proper treatment across the value chain. In the improved scenario (Figure 2) it is assumed that both black water and grey water will be appropriately treated through a mix of onsite and offsite treatment systems. The sewerage system will be able to treat combined volume of 96.3% of grey and black water. The rest 3.5% volume of wastewater will pass through septic tanks,

where the effluent will be let in to settle sewer and sludge will be regularly emptied and treated. As evident in figure below, none of the volumes will be highlighted through red or yellow traffic lights.

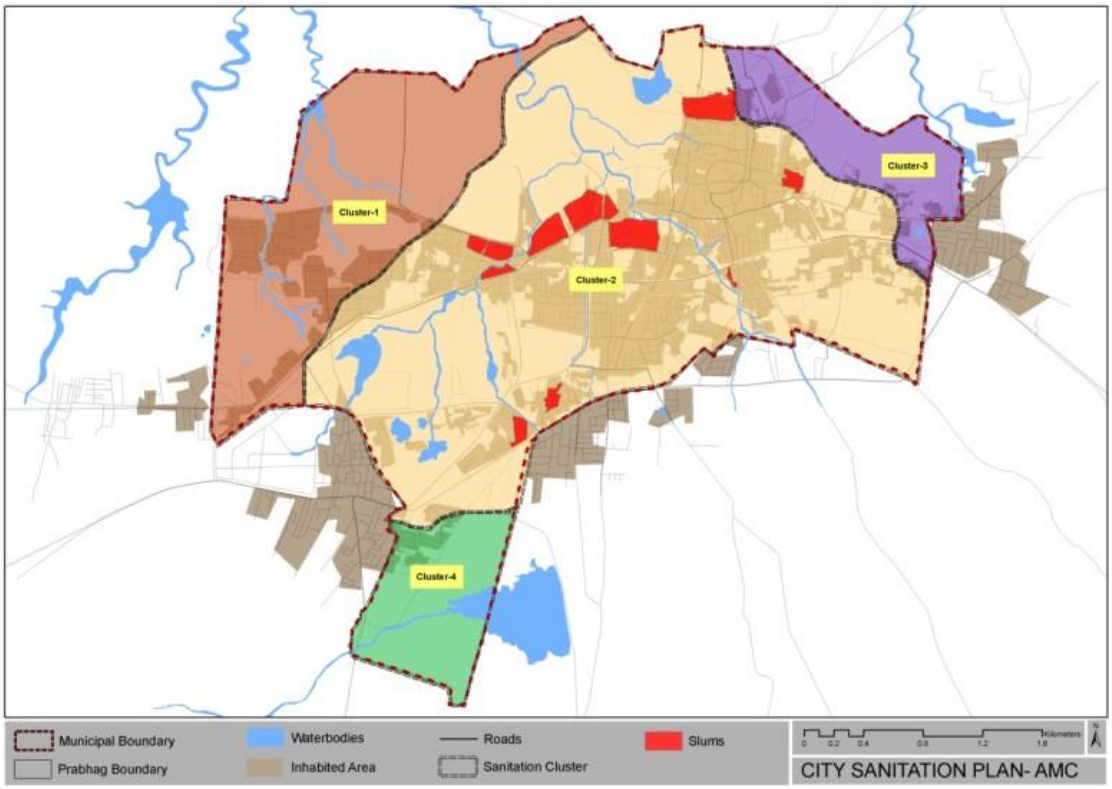
Figure 2: Targeted Waste Water Flows with CSP Interventions in Ambajogai



Green lights illustrate that entire waste water volumes are treated through septic tanks, STPs or appropriately reused in the value chain. The respective volumes for effluent and black water and methods for treatment are illustrated in figure below.

Strategies for wastewater management at city level

With an overview of existing urban sprawl of the town, existing waste management practices and funds available with the local authority, various technological options were considered and assessed for developing conveyance system for the city. A scheme is designed for the development and implementation of underground sewerage system in Ambajogai Municipal Council area for cluster 2. The project comprises of collecting sewers, trunk mains, property sewer connections, Pumping stations, Rising mains & 1 STP of capacity 10.5 MLD. Provision of STP will provide treated effluent which can be used for Irrigation or can be let out in the river. The scheme has been designed for 30 years. The location of STP is proposed on the downstream of the river towards north part of the city.



Sanitation cluster 1 and 3 are smaller clusters as compared to cluster 2. Cluster 4 has slope in different direction than other three. From the comparative analysis in CSP it has been noticed that different alternative are suitable for different zones. Moreover, sometimes few alternatives may be applied in combinations due to different level of interventions. As per the provisions of the earlier drainage scheme, a centralised sewer network has been proposed for Cluster 2 (as illustrated in the Map above), while Clusters 1, 3 and 4 (including Barula Talab from Cluster 2) were un served pockets for which low cost decentralised options for wastewater management are being envisaged and further feasibility studies are required to be explored.

Rationale for the feasibility study

As mentioned in above description, decentralized sanitation options were required to be explored for Sanitation cluster 1,3 and 4 as they are not part of the centralized sewerage scheme that is being developed for Cluster 2 during the CSP exercise. The project aims to build a case for decentralised sanitation infrastructure for the other clusters (1,3 and 4) based on the following presumptions:

1. Technical Ease of Operation
2. Socio-economic sustainability – low pay back period
3. Low O&M cost
4. Environmental sustainability – less energy footprint

The fundamental assumption among wastewater practitioners is that providing conventional sewers in low lying areas can be resource intensive and incur high capital expenditure (CAPEX) as well as high operation and maintenance expenditure (OPEX). Instead, providing decentralized solutions for both the conveyance and treatment of wastewater was presumed to be more financially viable and easy to operate and maintain. In this regard, the study findings suggested the need to weigh the viability of decentralized solutions based on site specific criteria. For instance, in the case of Ambajogai, it was clear that the cost of capital investment for a decentralized solution was on the higher side compared to a centralized/conventional solution, but what made it more viable was its long term annual operation and maintenance costs, which were exceedingly lower (1.5-2%) compared to what it was for conventional systems (12%).

The study was also done on the premise that high quantum of energy would be required to pump wastewater from low lying clusters into the centralized sewer network, to be conveyed to the sewage treatment plant. Instead, facilitating the conveyance of wastewater to decentralized treatment sites, through gravity using the local site topography could prove less energy intensive.

Apart from exploring the technical and financial viability of alternative options for wastewater management, an objective of the project was also to provide solutions to un-served areas.

Project Cluster Profiling

As per city sanitation plan (CSP) of Ambajogai, the sanitation situation in the town has been studied spatially by dividing the town into regional divisions or clusters, based on parameters like:

1. Natural Topography (terrain, slope direction and land cover)
2. Existing natural drainage system, and
3. Human interventions (such as urban development activities like construction of buildings, roads)

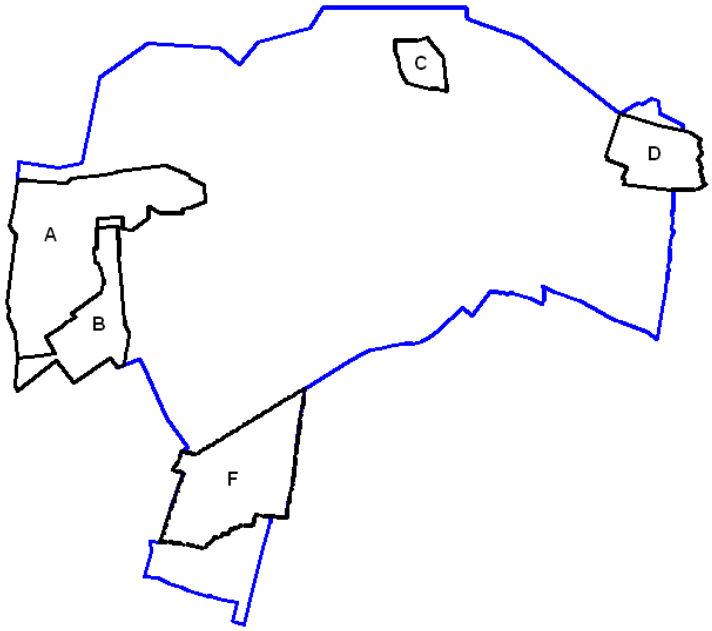
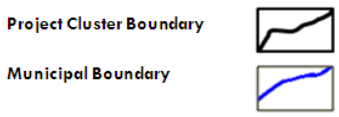
This is governed by the premise that the conveyance and disposal of domestic wastewater (generated in the town) is governed by the topography and natural drainage pattern flowing in the town. Within the study undertaken in this project, the same paradigm of regional classification to better evaluate the project areas is adopted. The sanitation clusters of Ambajogai are presented in table below and illustrated in the map following the table.

Within each of the clusters, a selected portion of area (as illustrated below) was demarcated for which low cost decentralized wastewater treatment solutions had to be determined. The details of these selected parcels and the sanitation clusters they fall within are illustrated in the following table.

Name of selected cluster:	Label in map:	Sanitation Cluster:	Area (in sq km):	Population (2015):	Water supply (MLD)	Wastewater generation (MLD)	Prabhag Number:
Kranti Nagar/Lal Nagar Non notified slum area	A	Cluster 1	0.95	4184	0.25	0.20	Prabhag 6
SRT Hospital Area	B	Cluster 1	0.36	3060	0.30	0.24	Prabhag 6
Barula Talab	C	Cluster 2	0.10	2888	0.28	-	Prabhag 1
Area behind Yogeshwari College	D	Cluster 3	0.28	1723	0.17	0.14	Prabhag 3
Mouli Nagar Area	F	Cluster 4	0.66	4533 (Within municipal limits) + 965 (Outside Municipal limits)	0.55	0.44	Prabhag 7

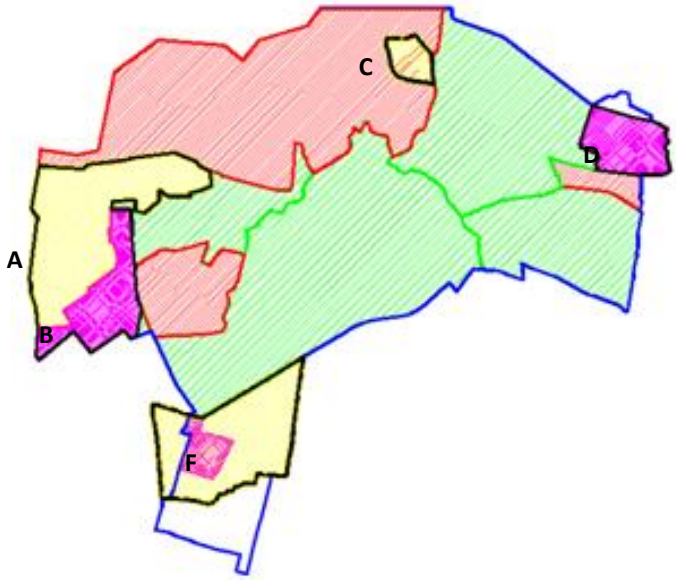
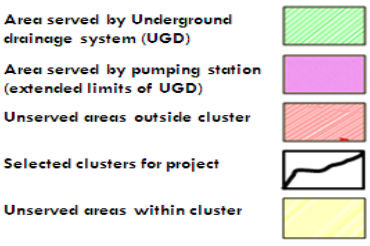
Note: These figures are for the year 2015

Source: Ambajogai Underground Drainage Scheme, Detailed Project Report; Solid Core Consultants Pvt. Ltd; and in consultation with the Ambajogai Nagar Parishad

Clusters selected for project	Legend
	
	Note: These clusters were demarcated in consultation with the PAS team at CEPT University and officials of Ambajogai Nagar Parishad. In subsequent visits, the cluster underwent minor changes.

Source: The cluster boundaries have been decided in consultation with Ambajogai Nagar Parishad officials and with PAS team

The areas where the underground drainage system is proposed to extend (as per the latest scheme), is presented in the following illustration.

Citywide coverage of the latest underground drainage scheme of Ambajogai	Legend
	
	Note: These clusters were demarcated taking into account: 1. The covereage of sewerage system in (latest UGD Scheme) detailed project report of Ambajogai Nagar Parishad 2. Consultation with PAS team and Ambajogai Nagar Parishad officials

Source: Ambajogai Underground Drainage Scheme, Detailed Project Report; Solid Core Consultants Pvt. Ltd

Wastewater Management scenario in each cluster

1. Kranti Nagar/Lal Nagar

Kranti Nagar/Lal Nagar is entirely an indigenously developed residential non-notified slum settlement. The only aspect of wastewater that could be considered here is the greywater from the households. Presently this is let out into open drains, while in few households, it is used for gardening. Since all households are connected to pits, the effluents are allowed to percolate into the soil and there is no need for conveyance of black water. In certain areas, stagnation of greywater is observed, emerging from the households. The issue in Kranti Nagar/Lal Nagar is the pollution and nuisance caused by letting greywater into the open; though can only pose an issue in the long run. Blackwater is not an issue, as the effluent from the latrines percolate into the soil, which is 1m of soft rock followed by 3 m of hard rock, followed by a ground water table of 40 to 50 mts. As such the predicament of greywater needs to be addressed.

2. SRT Hospital

The wastewater generation from the SRT Hospital area is around 244.8 cu m (2015) (as estimated based on the no. of residential units derived from the hospital authorities). As per the provisions of the UGD scheme for Ambajogai, the in-patient ward has been connected with the conventional sewer network, while the residential quarters are not. The hospital precinct is a planned layout and this allows for relatively better management of wastewater. The land available for setting up of pumping station shall be explored for provision of decentralised treatment unit based on the volumes of wastewater generated and flow pattern within the hospital campus. The possibility of further decentralisation of wastewater treatment within the campus will be explored.

3. Barula Talab

The temple was granted permission by the Nagar Parishad to divert the wastewater from the storm water drain – otherwise flowing North West through the storm water drains – towards the fields (from where it also flows into the Talav). During the monsoons, the quantity of storm water in the drain is high and overflows into the Talav, which is mixed with the wastewater discharged from the households. In order to avoid the same, the municipality has proposed to change the direction of water flow into the talav by raising the road level. With this, there will be no wastewater entering the talav.

4. Yogeshwari College

Presently, both the septic tank outlet and outlets from kitchens and bath (separate outlet observed for greywater) are let into roadside open drains. The coverage of conveyance network in this network is also not complete. There is also no arrangement for treatment of this wastewater which is found to stagnate in different parts of this cluster. For the wastewater led into drains from households (both black water and greywater), there is no treatment facility prevailing. In the Yogeshwari College area, most households have not undertaken desludging since the construction of their septic tanks (which in most cases range from 10-15 years). This is because, the septic tanks are either below the toilet itself or in some places built outside the house but without access covers. In that case, access to septic tank for

cleaning is difficult. The outlets of the septic tank as well as kitchen and bathroom were connected to road side drains.

5. Mouli Nagar

Mouli Nagar is entirely developed as a residential locality. The black and greywater generated from households is drained through road side open drains (which do not cover the entire stretch of the cluster and have been constructed with very limited consideration for technical design standards).

For the wastewater led into drains from households (both blackwater and greywater), there is no treatment facility prevailing. In Mouli Nagar, it was observed that from the last 10-15 years, people have not desludged their septic tanks. Soak pits were not found in any of the households in Mouli Nagar. This is in spite of the fact that the building by-laws state that it is necessary to develop an onsite treatment facility of septic tank followed by soak pit. However, very few buildings (especially newly developing ones) follow the system.

Strategies for improvement in the selected clusters:

Criteria for selection of appropriate technology

Sanitation technologies for individual houses, communities or towns should be selected based on local conditions and user requirements. The criteria for selection of appropriate technology are illustrated as follows (criteria adapted from WSP 2008):

Proposed Waste Water Management options for each clusters

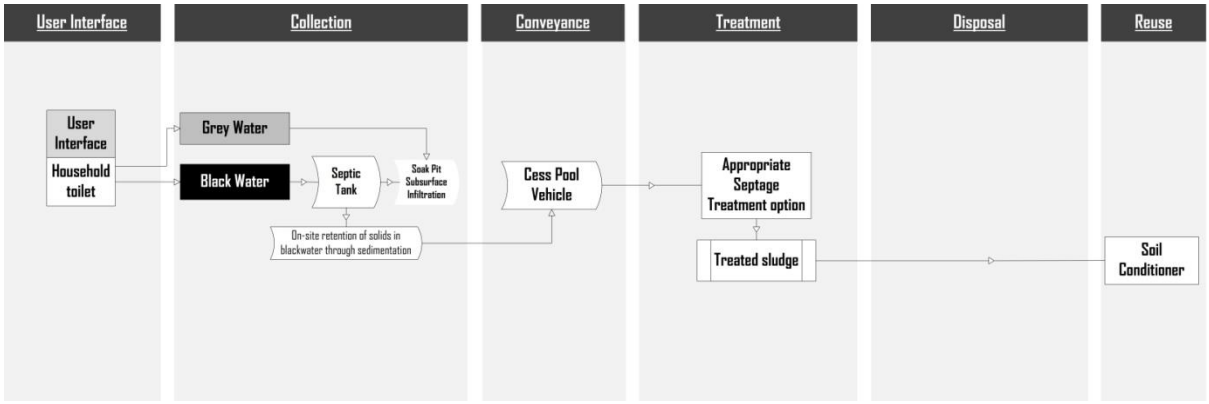
Keeping in view the discussions with key stakeholders of the project, the field visit and review of the existing data (present and projected population, nature of development pattern in terms of prevailing land use) related to sanitation, the following options[1] were derived as possible ways for wastewater management in the 4 clusters. Following options were considered for waste water management options for each cluster.

[1] The concepts have been conceived broadly of two types:

a. On-site Options for wastewater management (on site decentralised treatment)
b. Integration with the centralised city level infrastructure

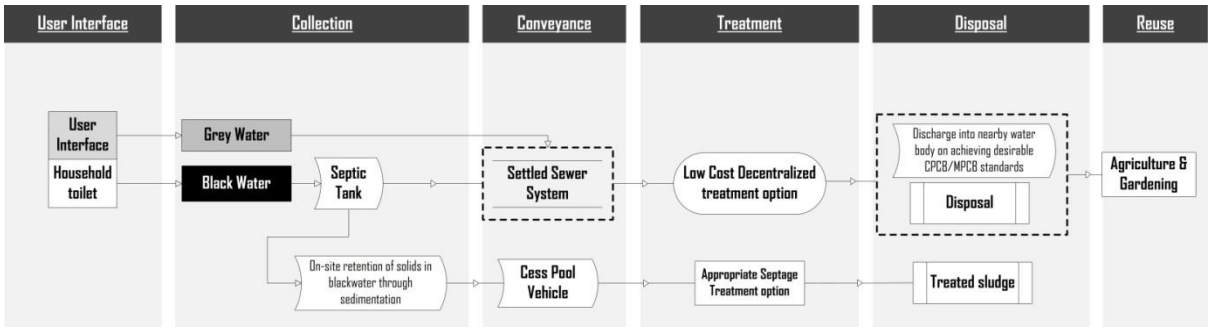
Option 1 – Septic Tank + Soak pit + Septage Management: *"On-site retention of solids in blackwater through sedimentation in septic tanks, followed by sub surface infiltration of wastewater into soil, followed by conveyance of deposited sludge from septic tank through emptier trucks to a treatment site"*

Illustration of Option 1



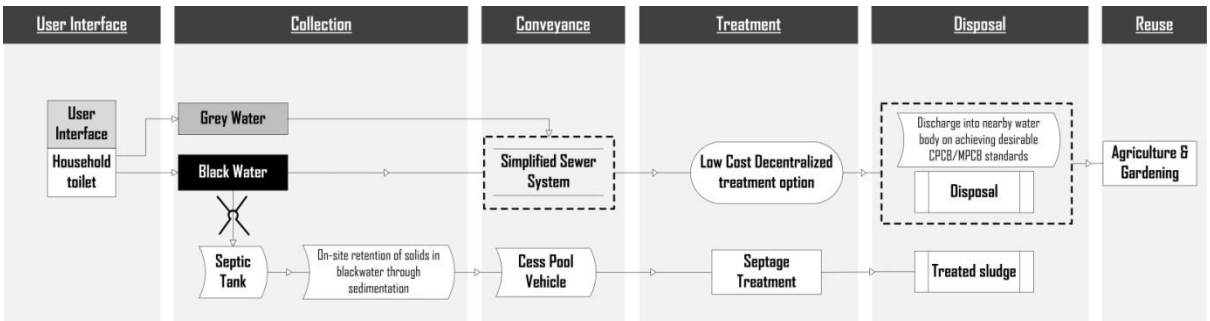
Option 2 – Septic Tank + Settled Sewer + Decentralized Wastewater Treatment Option + Septage Management: *"On-site retention of solids from blackwater through sedimentation in septic tanks/interceptor tanks, followed by conveyance of wastewater (supernatant and greywater) through a settled sewer system and off-site treatment by decentralised treatment unit"*

Illustration of Option 2



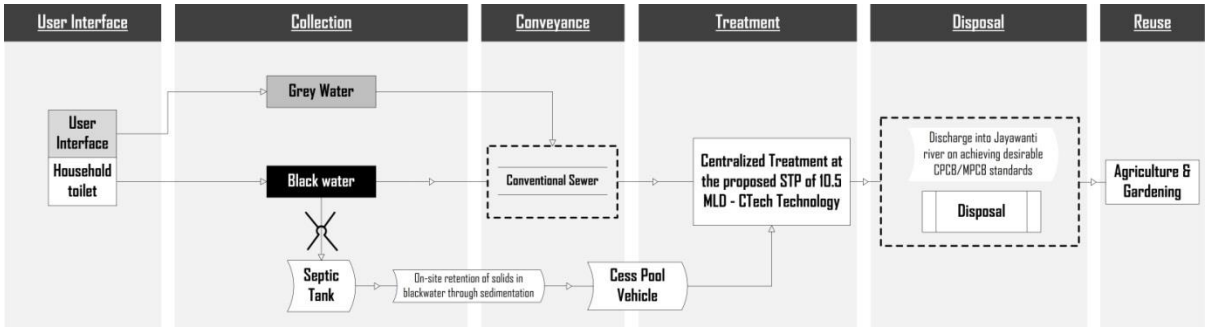
Option 3 – Simplified Sewer + Decentralized Treatment Option: *"Combined discharge of blackwater (with solids) and greywater in a simplified sewerage network and off-site treatment by a decentralised treatment unit"*

Illustration of Option 3



Option 4: Conventional Sewer + Sewage Treatment Plant: *"Collection and conveyance of wastewater to the proposed conventional centralised sewer network at a city level"*

Illustration of Option 4



A sanitation situation analysis was undertaken by CDD Society's team to understand the wastewater value chain in each project cluster. Keeping in view the discussions with key stakeholders of the project, the field visit and review of the existing data (present and projected population, nature of development pattern in terms of prevailing land use) related to sanitation, the following options[2] have been derived as possible ways to wastewater management for each cluster. Each option was suggested with varying priority based on their technical and financial viability (as illustrated in the matrix below):

WW mgmt concept / Cluster / Application	Wastewater management Option 1 (ST+SP+SMP)	Wastewater management Option 2 (ST+Settled Sewer+DEWATS+SMP)	Wastewater management Option 3 (Simplified Sewer+DEWATS)	Wastewater management Option 4 (Conv. Sewer+STP)
Mouli Nagar	**Suitable Option – 3**	Suitable Option – 2	**Suitable Option - 1**	14.4% coverage of Conventional sewer system
Kranti Nagar (Lal Nagar Slum settlement)	**Suitable Option - 1**	**Suitable Option – 3**	Suitable Option - 2	Not proposed for this area
Behind Yogeshwari College	**Suitable Option - 1**	**Suitable Option – 3**	Suitable Option - 2	A pumping station has been proposed to cover this area
SRT Hospital (residential)	**Suitable Option - 3**	Suitable Option – 2	**Suitable Option - 1**	A pumping station has been proposed to cover this area

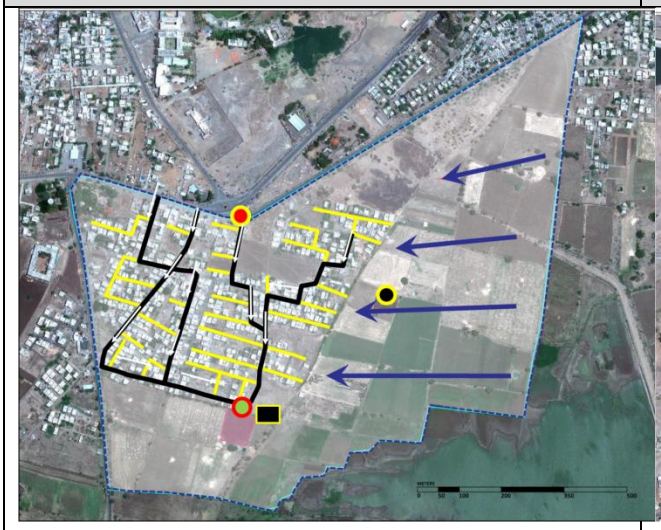
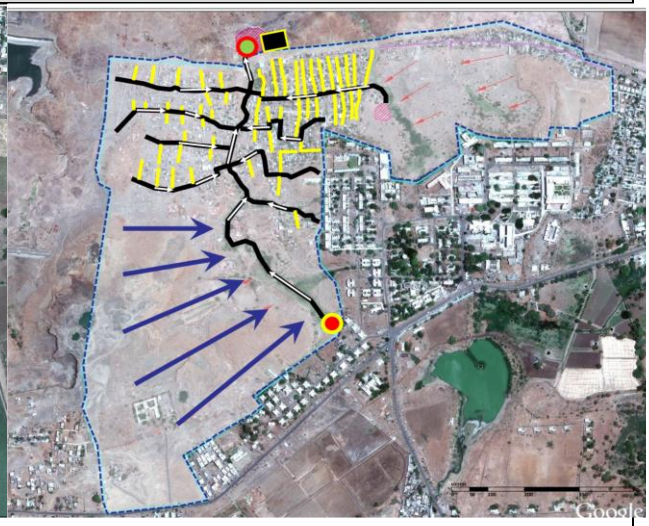
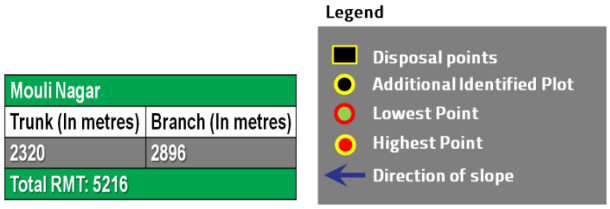
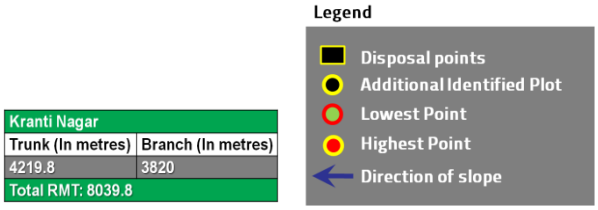
Details on Conveyance system

The following table illustrates the length of the network in the selected 4 clusters, while implementing the conveyance medium of settled or simplified sewers:

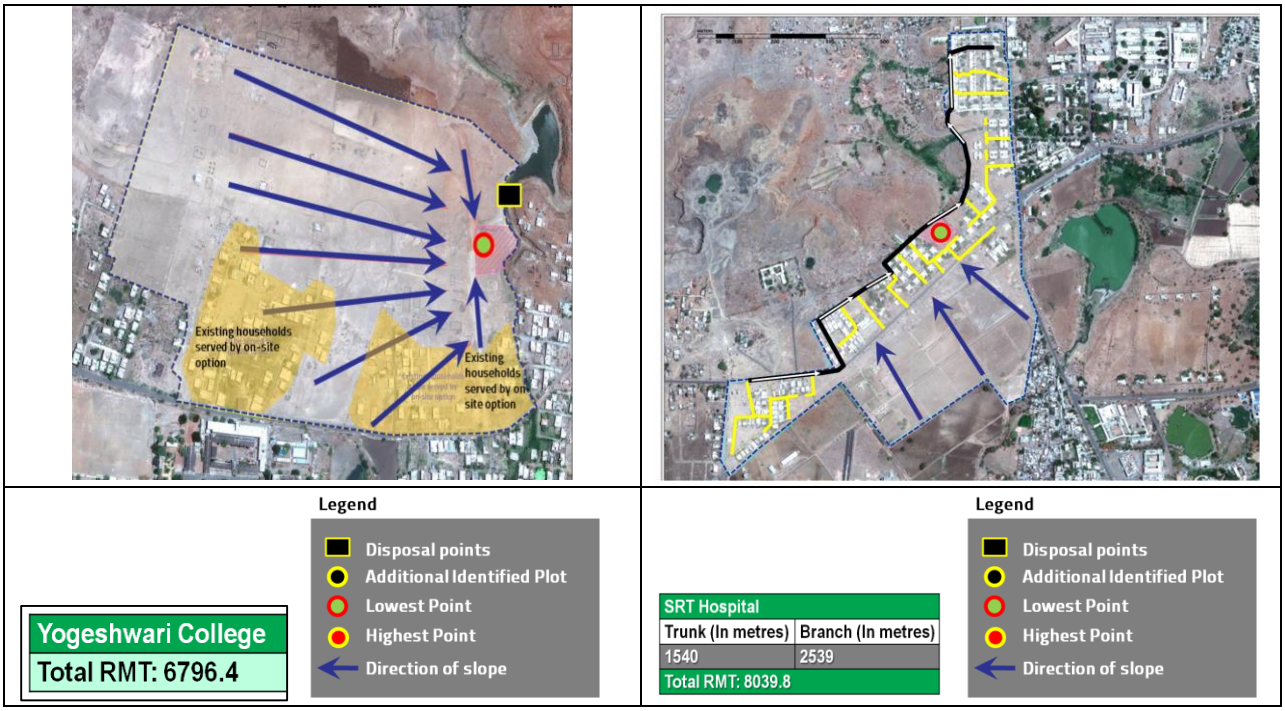
[2] The concepts have been conceived broadly of two types:
a. On-site Options for wastewater management (on site decentralised treatment)
b. Integration with the centralised city level infrastructure

Cluster Name	Trunk (In metres)	Branch (In metres)	Total RMT (In metres)
Mouli Nagar	2320	2896	5216
Kranti Nagar/Lal Nagar	4219.8	3820	8039.8
Yogeshwari College[3]			6796.4
SRT Hospital	1540	2539	4079

Tentative sewer alignment and Disposal location for each cluster

Mouli Nagar	**Kranti Nagar/Lal Nagar**
	
	
Yogeshwari College Area	**SRT Hospital Area**

[3] The length of network for Yogeshwari College area was estimated by extrapolating the area specification of the model residential layout provided by the municipality,



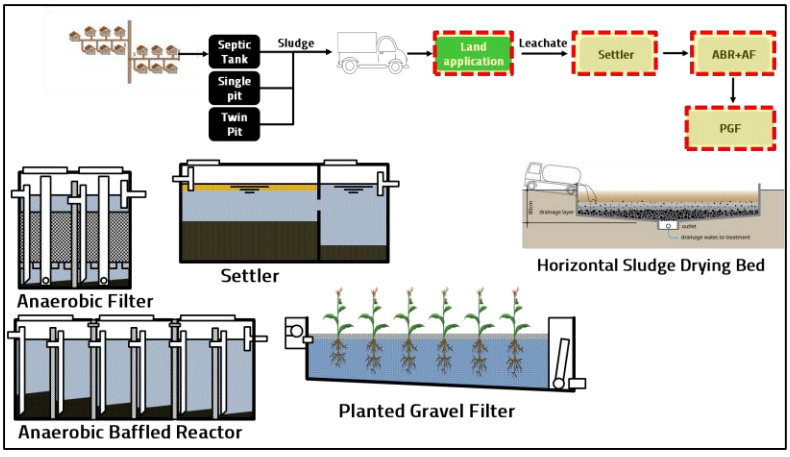
Note 1: The length of network was estimated by extrapolating the area specification of the model residential layout provided by the municipality,

Note 2: The tentative sewer tentative sewer alignment has been developed based on the slope profile of the respective cluster

Proposed technological options for Septage Management

'*Sludge Drying Bed*' due to its simplicity and reliability and minimal operation and maintenance considerations, was selected as the technology option for septage treatment. The proposed combination of technology for sludge/septage treatment has been illustrated in the image below as follows:

Proposed Combination for septage management



Source (Image): Elizabeth Tilley, C. L. (2008). Compendium of Sanitation Systems and Technologies. Geneva, Switzerland: EAWAG/SANDEC; Swiss Federal Institute of Aquatic Science & Technology / Water and Sanitation in Developing Countries

Sasse, L. (1998). DEWATS: Decentralised Wastewater Treatment in Developing Countries. BORDA, Bremen, Germany.

The selected approach for septage treatment is the Unplanted Sludge Drying Bed which is a simple, permeable bed that, when loaded with sludge, collects percolated leachate and allows the sludge to dry

by evaporation. Approximately 50% to 80% of the sludge volume drains off as liquid. The resulting leachate is further treated by the combination of Settler, Anaerobic Baffle Reactor, Anaerobic Filter follows by the Planted gravel filter.

The capital investment estimated (for the year 2045) for Septage Conveyance (Emptier Trucks) infrastructure for selected clusters is estimated as follows:

Fecal Sludge Management Plan[4][5]		
Sr.No	**Description**	**No.**
1	Population	23457
2	Total households (HHs)	4603
3	HHs having toilets with septic tanks	4603
1	Septic tank cleaning cycle (Years)	3
4	Total septage generated per HHs in a year (as per USEPA, 230 litre/year/person) (cu m)	1.17
5	Total septage generated after 3 years in each HHs (if cleaning cycle is 3 years) (cu m)	3.52
3	No. of working days	300
6	Truck capacity (cu m)	5
2	No. of HHs level septic tanks to be annually cleaned (no)	1534
7	No. of septic tanks to be cleared daily (assuming 300 working days) (no)	5
8	Total septage to be cleared (cu m/day) (septage cleaned after 3 years)	17.98
9	No. of trips possible per vehicle per day (trip/day)	3
10	**No. of vehicles required (no)**	**2** (of 5000 Liters capacity)
11	**Standby vehicles (10-25%)**	**10%**
12	**Total Vehicles required**	**2**

- **Cost for Drying Bed: Rs. 40 lakh[6]**
  Note: This is assuming 8 Beds of the size of 75 SQ M each (15 M X 5 M), and septage would be dropped at depth of 40 CM; 30 cm depth of filter medium
- **The cost of ancillary infrastructure, like roof, road, ramps, shed, electro mechanical equipment, feeding tank have not been included (this may tentatively estimated at 30-40 lakh)**

Leachate Treatment: Rs. 30 lakh for treatment

- Effluent from the unplanted drying bed would be collected in the ABR and led into AF, post which it will be led into a PGF for advanced treatment.

[4] The cost mentioned above is indicative only, assuming every household has a septic tank

[5] For the project clusters of Kranti Nagar/Lal Nagar, Mouli Nagar, Yogeshwari College and SRT Hospital, the 5000 liter capacity emptier truck is envisaged as adequate to facilitate Household level sludge collection.

[6] The cost per bed can estimated at a minimum of Rs.2.25 lakh per bed to a maximum of Rs.5 lakh per bed varying based on actual design and filter medium used

Investment Requirement:

This section provides the details of gross investment & annual O&M required for each project cluster. The cluster wise cost was calculated for different waste water management option based on the population served, waste water generated and length of sewer network required. Cost estimation is planned for two phases; one till year 2030 and another one till year 2045.

Gross Costing Summary of Proposal for up to 2030

WW mgmt concept / Cluster Application	Wastewater management Option 1 (ST+SP+SMP)	Wastewater management Option 2 (ST+Settled Sewer+ DEWATS+SMP)	Wastewater management Option 3 (Simplified Sewer+DEWATS)	Wastewater management Option 4 (Conv. Sewer+STP)
Mouli Nagar	**CAPEX: 128 Lakh Annual OPEX: 12 Lakh Area Required: 700 SQ.M. Population Served: 23457**	CAPEX: 315.96 Lakh Annual OPEX: 3.63 Lakh Population Served: 9327	**CAPEX: 336.82 Lakh Annual OPEX: 4.76 Lakh Population Served: 9327**	CAPEX: 215.8 Lakh Annual OPEX: 23.16 Population Served: 7690
Kranti Nagar/Lal Nagar (Lal Nagar Slum settlement)		CAPEX: 289.67 Lakh Annual OPEX: 2.79 Lakh Population Served: 5035	CAPEX: 322.03 Lakh Annual OPEX: 4.22 Lakh Population Served: 5035	CAPEX: 0 Annual OPEX: 0
Behind Yogeshwari College		CAPEX: 246.74 Lakh Annual OPEX: 2.5 Lakh Population Served: 3400	CAPEX: 273.9 Lakh Annual OPEX: 3.7 Lakh Population Served: 3400	CAPEX: 237.02 Lakh Annual OPEX: 25.44 Lakh Population Served: 3514
SRT Hospital (residential)		CAPEX: 189.76 Lakh Annual OPEX: 2.71 Lakh Population Served: 2406	**CAPEX: 206.6 Lakh Annual OPEX: 3.6 Lakh Population Served: 20168**	CAPEX: 312.61 Lakh Annual OPEX: 33.55 Lakh Population Served: 2406
TOTAL		**CAPEX[7] : 1042.13 Lakh Annual OPEX: 9.13 Lakh Population Served: 20168**	**CAPEX : 1139.35 Lakh Annual OPEX: 16.28 Lakh Population Served:**	**CAPEX : 765.43 Lakh Annual OPEX: 82.15 Lakh Population**

[7] The CAPEX for WW Mgmt Option 2 and 3 are mentioned for up to secondary treatment level for the year 2045

WW mgmt concept / Cluster Application	Wastewater management Option 1 (ST+SP+SMP)	Wastewater management Option 2 (ST+Settled Sewer+ DEWATS+SMP)	Wastewater management Option 3 (Simplified Sewer+DEWATS)	Wastewater management Option 4 (Conv. Sewer+STP)
			20168	**Served: 13610**

Note: The highlighted cells (in light blue) in the above table illustrate the preferred options for implementation in the respective clusters

Gross Costing Summary of Proposal for up to 2045

WW mgmt concept / Cluster Application	Wastewater management Option 1 (ST+SP+SMP) [8]	Wastewater management Option 2 (ST+Settled Sewer+DEWATS+SMP) [9]	Wastewater management Option 3 (Simplified Sewer+DEWATS)	Wastewater management Option 4 (Conv. Sewer+STP)[10]
Mouli Nagar	**CAPEX: 128 Lakh** **Annual OPEX: 12 Lakh** **Area Required: 700 SQ.M.**	CAPEX: 353.66 Lakh Annual OPEX: 3.83 Lakh Population Served: 11585	**CAPEX: 374.59 Lakh** **Annual OPEX: 4.96 Lakh** **Population Served: 11585**	CAPEX: 228.92 Lakh Annual OPEX: 24.58 Lakh Population Served: 9552
Kranti Nagar/Lal Nagar (Lal Nagar Slum settlement) [11]		CAPEX: 299.89 Lakh Annual OPEX: 2.84 Lakh Population Served: 5887	CAPEX: 332.26 Lakh Annual OPEX: 4.27 Lakh Population Served: 5887	CAPEX: 0 Annual OPEX: 0
Behind Yogeshwari College		CAPEX: 249.68 Lakh Annual OPEX: 2.53 Lakh Population Served: 3514	CAPEX: 276.84 Lakh Annual OPEX: 3.73 Lakh Population Served: 3514	CAPEX: 287.83 Lakh Annual OPEX: 25.53 Lakh Population Served: 3514

[8] In WW Mgmt Option 1, households need to have septic tank and soak pits, which is envisaged as a private cost
[9] Septage Mgmt costs need to be additionally factored
[10] WW Mgmt Option 4 does not serve the entire cluster but a part of it
[11] For Kranti Nagar/Lal Nagar, where majority of HHs have pit latrines, the installation of septic tanks with soak pits have to be envisaged

WW mgmt concept / Cluster / Application	Wastewater management Option 1 (ST+SP+SMP) [8]	Wastewater management Option 2 (ST+Settled Sewer+DEWATS+SMP) [9]	Wastewater management Option 3 (Simplified Sewer+DEWATS)	Wastewater management Option 4 (Conv. Sewer+STP)[10]
SRT Hospital (residential)		CAPEX: 195.66 Lakh Annual OPEX: 2.73 Lakh Population Served: 2471	**CAPEX: 212.5 Lakh** **Annual OPEX: 3.9 Lakh** **Population Served: 2471**	CAPEX: 313.07 Lakh Annual OPEX: 33.6 Lakh Population Served: 2471
TOTAL		**CAPEX: 1098.89 Lakh** **Annual OPEX: 11.93 Lakh** **Population Served: 23457**	**CAPEX: 1196.19 Lakh** **Annual OPEX: 16.86 Lakh** **Population Served: 23457**	**CAPEX : 829.82 Lakh** **Annual OPEX: 83.71 Lakh** **Population Served: 15537**

Note: The highlighted cells (in light blue) in the above table illustrate the preferred options for implementation in the respective clusters

As illustrated in the above table, though the capital investment for installing non-conventional systems (Wastewater management option 2 & 3) in the selected project clusters seems relatively higher compared to the conventional system, it should be noted that the non-conventional systems are serving only a share of the population in the project clusters (i.e. 15537), and it would incur greater capital investment to facilitate the network to the additional 7920 population. In addition, the operating expenditure for the non-conventional systems is much lower compared to the conventional system. For instance the OPEX for non conventional systems range from 1-1.5% of their CAPEX, as compared to 10% in the case of conventional systems. Option 1 dealing with septage management is certainly the least capital intensive, but comparatively, also has higher operation and maintenance requirements. As such, in gross terms, the wastewater management option 2 (namely ST + Settled Sewer + DEWATS + SMP) is the most favorable approach in both terms of capital expenditure and operating expenditure. However, these options can be adopted cluster wise in terms of the suitability of each wastewater management to the physiography of each regional setting (i.e. be it Mouli Nagar, Kranti Nagar, Yogeshwari College or SRT hospital), and the relative ease of installing the infrastructure.